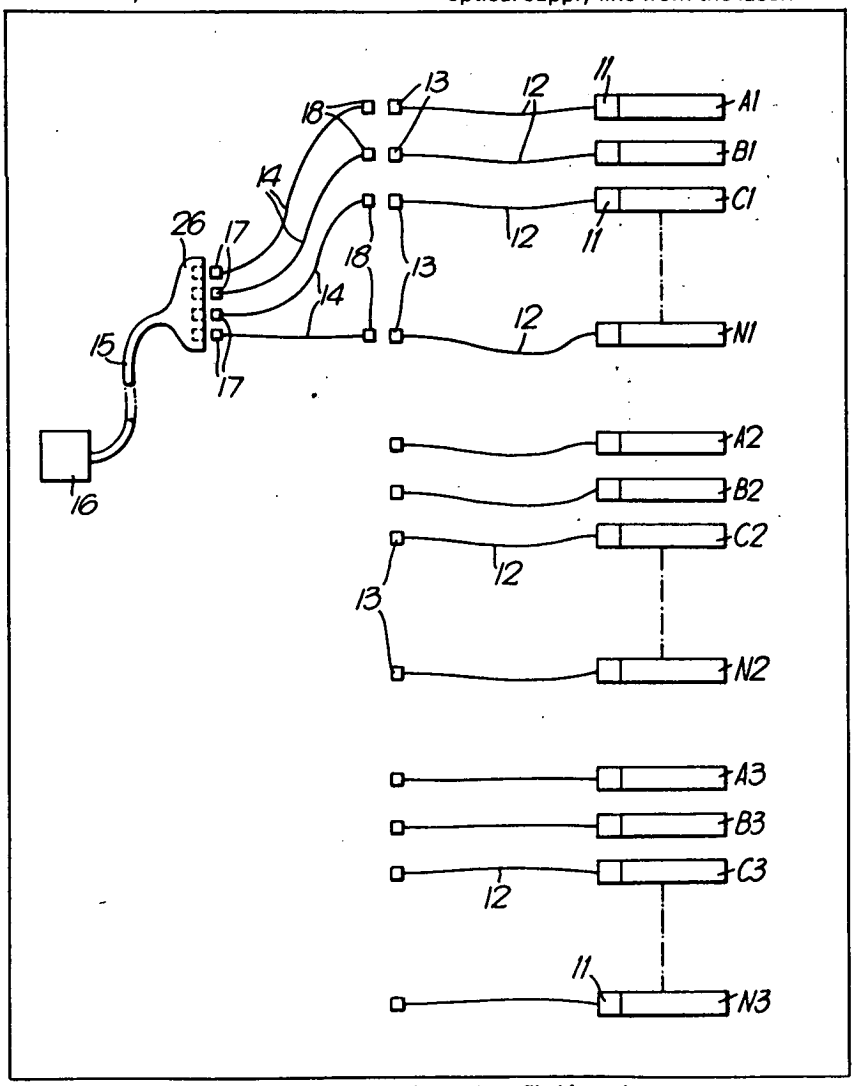
(12) UK Patent Application (19) GB (11) 2 063 964 A

(21) Application No 8026833
(22) Date of filing 18 Aug 1980
(30) Priority data
(31) 7229129 7929129
7929128
7936504
(32) 21 Aug 1979
21 Aug 1979
20 Oct 1979
(33) United Kingdom (GB)
(43) Application published
10 Jun 1981
(51) INT CL³
F42D 3/00
(52) Domestic classification
E1F 1
F3A C4
(56) Documents cited
None
(58) Field of search
E1F
(71) Applicants
Sightworth Limited,
Monkgate House,
Monkgate, York
(72) Inventor
Peter Christian Shann
(74) Agents
Alan Tromans & Co., 7
Seymour Road, Finchley,
London N3 2NG

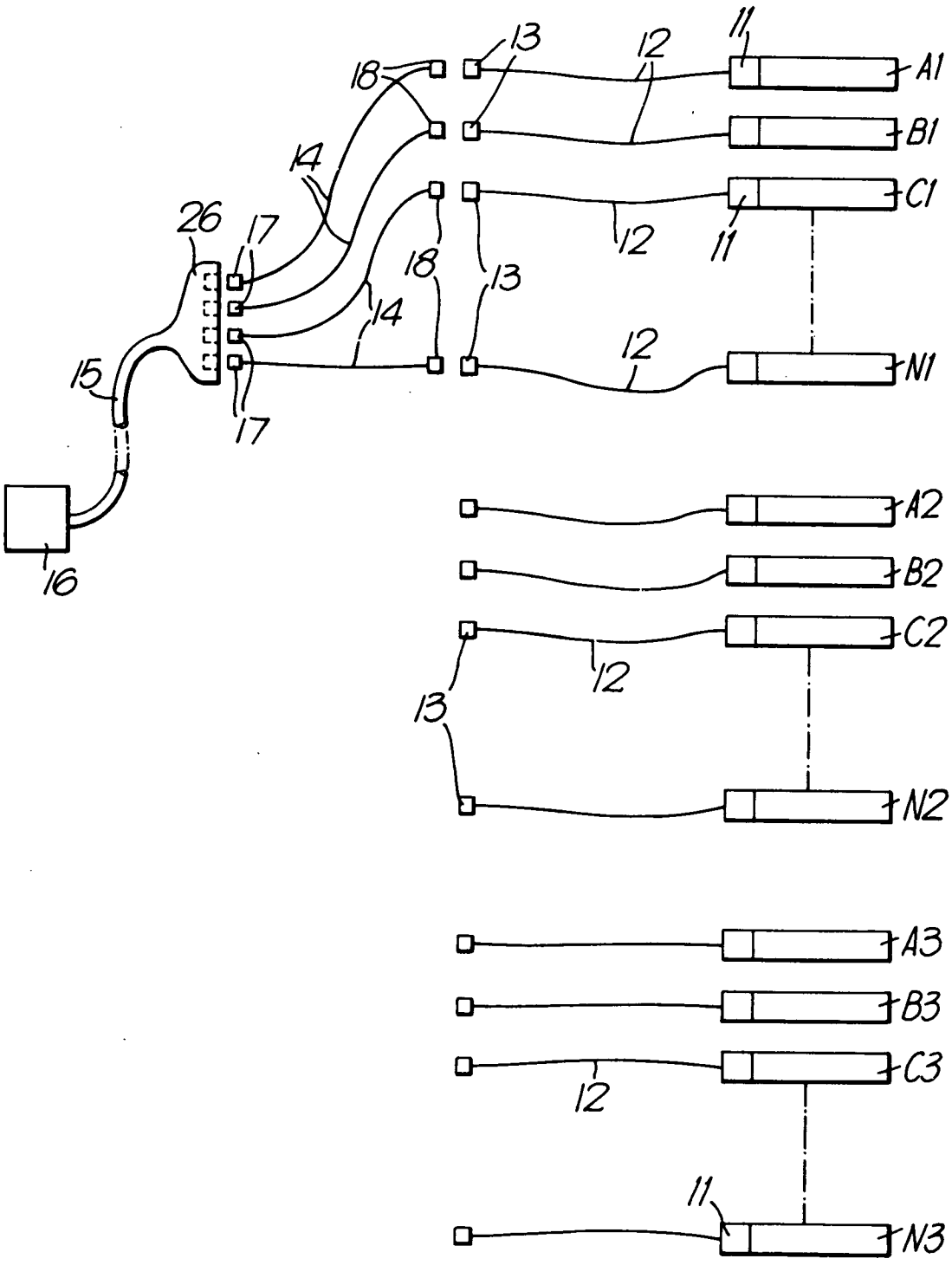
(54) Detonation of explosive charges

(57) Explosive charges are fitted with detonators 11 and detonated by means of a laser 16. Each detonator terminates one end of a length of optical fibre 12, 14 and is constituted and arranged to be actuated by optical energy received from the laser via said length connecting the opposite end of the first of said lengths with an optical supply line 15 leading from the laser and having an attenuation per unit length for the laser energy which is substantially smaller than that of the said lengths, passing energy from the laser to detonate the charge fitted with the detonator which terminates said first of said lengths, and subsequently detonating the remaining charges in turn by connecting the remainder of the said lengths with said supply line and passing energy from the laser, the connection of the said lengths with the supply line being effected by interengaging connecting components. The lengths of fibre are expendable and are desirably connected by interengaging components with a more permanent optical supply line from the laser.



The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

GB 2 063 964 A


11
13
12
18
A1
B1
14
C1
26
17
18
13
12
11
14
12
15
N1
17
16
A2
B2
C2
12
13
N2
A3
B3
C3
12
11
N3

SPECIFICATION

Detonation of explosive charges

The present invention relates to the detonation of explosive charges and has as an object the provision of a method whereby explosive charges can be detonated by laser energy in an economical manner.

By the present invention, there is provided a method of detonating a series of explosive charges by means of a laser which comprises fitting the charges with detonators each of which terminates one end of a length of optical fibre and is constituted and arranged to be actuated by optical energy received from the laser via said length, connecting the opposite end of the first of said lengths with an optical supply line leading from the laser and having an attenuation per unit length for the laser energy which is substantially smaller than that of the said length, passing energy from the laser to detonate the charge fitted with the detonator which terminates said first of said lengths, and subsequently detonating the remaining charges in turn by connecting the remainder of the said lengths with said supply line and passing energy from the laser, the connection of the said lengths with the supply line being effected by interengaging connecting components.

Examples of interengaging connecting components suitable for use in the present method are described in the specification of patent application No. 7913078 (2019032A) where it is shown that the laser energy for detonating explosive charges need not be transmitted from the laser without loss and need not follow a single optical path through the fibre system. It is found in practice that the laser is readily selected to give in each pulse an amount of energy which is substantially greater than the total energy required to actuate a set of detonators simultaneously. Because there is a surplus of energy available, loss can be tolerated at the interengaging components and arrangements made for dividing the energy between the detonators of a set need not be of such a precision design as to divide the energy into sensibly equal amounts.

In practice, the invention is applied to blasting operations in which sets of explosive charges are detonated in turn, usually with intervals between the detonations of the sets occupied by such site work as the clearance of rubble and the drilling of shot holes. Each explosive charge of the series aforesaid is one from a number of sets of charges to be detonated in turn and the lengths of fibre associated with the charges of a set are connected with the supply line simultaneously. It is advantageous to connect the lengths of fibre with the supply line via intermediate lengths of fibre.

The detonation of the charges damages the lengths of fibre terminating at the detonators. These lengths are therefore expendable and forming them of fibre having an attenuation which is high compared with that of the supply line from the laser contributes to the economy of the method. It cannot be predicted how far damage to fibres will extend and in a preferred arrangement the lengths of fibre and said intermediate lengths are renewed when damaged. With this arrangement the lengths of fibre terminating at the detonators and discarded after a set of charges has been fired can be provided in a length which is economic in the value of the optical fibre necessarily expended and in the packaging, transport and storage of detonators with the lengths of fibre attached.

The intermediate lengths of fibre may have an attenuation per unit length for the laser energy which is high in comparison with that of the supply line. They may be formed of the same material as the lengths terminating in the detonators.

It is shown in patent application 7929129 that a detonator for laser actuation advantageously has, adjacent to the end face of its length of optical fibre, a body of flashing composition of which the active material is selected from the mono and di-nitro resorcinols and their salts, the mono and di-nitro resorcinols and their salts and mixtures of two or more of these substances. This arrangement is preferred in the practice of the present invention.

For supplying the laser energy to the supply line it is preferred to employ an arrangement as described in patent application 7929128.

The following description in which reference is made to the accompanying diagrammatic drawing is given in order to illustrate the invention.

The drawing shows three sets *A*1, *B*1, *C*1—*N*1; *A*2, *B*2, *C*2—*N*2; and *A*3, *B*3, *C*3—*N*3 of charges to be detonated in turn. Each charge is provided with a detonator 11 which terminates a length of optical fibre 12. The detonators and their fibres may be as described in patent application 7929129. An example of a suitable fibre is silica fibre of diameter 0.2 mm sheathed with silicone rubber and an outer protective layer. Such a fibre has an attenuation of 26 dB/Km at a typical laser energy wavelength. Typically each length is 10 to 15 metres from end to end.

In the drawing all the charges are shown in association with their detonators and fibres but, in practice, it is usual to fit them to each set only when it is being prepared for detonation.

At the ends remote from the detonators, the fibres 12 are fitted with plugs 13.

To fire a set of charges, the associated fibres are connected by intermediate lengths of fibre 14 with an optical supply line 15 leading from a laser device 16 to a multiple output socket 26 by inserting plugs 17 therein. Connection of fibres 12 and 14 is made by inserting plugs 13 into sockets 18. These plugs and sockets may be as described with reference to Fig. 9 or 10 of application 7913078.

Fibres 14 may be of the same specification as fibres 12. Supply line 15, which is required to convey the energy from the laser 16 located at a safe distance from the blasting site, is a heavily

sheathed cable having an attenuation of, say, 5 dB/Km. Its cost per unit length can be as much as 100 times that of fibres 12 and 14.

A preferred arrangement for the laser 16, supply line 15, and output socket 26, is described in application 7929128.

When set *A*1—*N*1, shown connected in the drawing, has been detonated, the fibres 14 are inspected and those damaged by debris are replaced, together with their plugs 17 and sockets 18, from stock. After the necessary site work, the next set *A*2—*N*2 is prepared for detonation by inserting the plugs 13 thereof into the sockets 18 some of which may have been replaced together with their associated fibres 14.

Set *A*3—*N*3 and any further sets are detonated after a similar procedure.

Reference has been made hereinbefore to the firing of a series of charges in turn. It will be appreciated that an output point of multiple output socket 26 is employed for this purpose, the members of the series being taken in turn, one from each of the sets which is to be detonated simultaneously. It will also be appreciated that a plurality of series is detonated during a given time period and that the members for a particular series do not have to be identified in advance. They can be taken at random during the overall operation.

It is to be understood that the method described with reference to the drawing can be varied to suit particular circumstances. The number of charges need not be the same in every set and the equipment can be chosen with reference to its availability once the principles of the invention have been understood.

CLAIMS

1. A method of detonating a series of explosive charges by means of a laser which comprises fitting the charges with detonators each of which terminates one end of a length of optical fibre and is constituted and arranged to be actuated by optical energy received from the laser via said length, connecting the opposite end of the first of said lengths with an optical supply line leading from the laser and having an attenuation per unit length for the laser energy which is substantially smaller than that of the said length, passing energy from the laser to detonate the charge fitted with the detonator which terminates said first of said lengths, and subsequently detonating the remaining charges in turn by connecting the remainder of the said lengths with said supply line and passing energy from the laser, the connection of the said lengths with the supply line being effected by interengaging connecting components.

2. A method according to claim 1 in which each explosive charge of the series is one from a number of sets of charges to be detonated in turn and the lengths of fibre associated with the charges of a set are connected with the supply line simultaneously.

3. A method according to either of claims 1 or 2 in which the lengths of fibre are connected with the supply line via intermediate lengths of fibre.

4. A method according to claim 3 in which the intermediate lengths of fibre are connected with both the said lengths and the supply line by interengaging components.

5. A method according to either of claims 3 or 4 in which the intermediate lengths have an attenuation per unit length for the laser energy which is high in comparison with that of the supply line.

6. A method according to any one of claims 1 to 5 in which each detonator has, adjacent to the end face of its length of optical fibre, a body of flashing composition of which the active material is selected from the mono and di-nitro resorcinols and their salts, the mono and di-nitro resorcinols and their salts and mixtures of two or more of these substances.

7. A method according to claim 2 in which the energy transmitted by the lengths of fibre simultaneously differs in amount from length to length.

8. A method of detonating a series of explosive charges by means of a laser, substantially as hereinbefore described and illustrated by reference to the accompanying drawing.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1981. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.